

# Geologic Resource Evaluation Scoping Summary Chiricahua National Monument, Arizona

Geologic Resources Division  
National Park Service  
US Department of the Interior



The Geologic Resource Evaluation (GRE) Program provides each of 270 identified natural area National Park Service units with a geologic scoping meeting, a digital geologic map, and a geologic resource evaluation report. Geologic scoping meetings generate an evaluation of the adequacy of existing geologic maps for resource management, provide an opportunity for discussion of park-specific geologic management issues and, if possible, include a site visit with local experts. The purpose of these meetings is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and potential monitoring and research needs. Outcomes of this scoping process are a scoping summary (this report), a digital geologic map, and a geologic resource evaluation report.

The National Park Service held a GRE scoping meeting for Chiricahua National Monument (CHIR) on April 5, 2006, at park headquarters. Stephanie O'Meara (CSU) facilitated the discussion of map coverage and Sid Covington (NPS GRD) led the discussion regarding geologic processes and features at the monument. Ed du Bray (USGS) led a field trip to the top of Sugarloaf Mountain after the meeting. Participants at the meeting included NPS staff from the park, Geologic Resources Division, and the Intermountain Region and cooperators from the United States Geological Survey (USGS), Arizona Geological Survey (AZGS), and Colorado State University (CSU) (see table 3). This scoping summary highlights the GRE scoping meeting for Chiricahua National Monument including the geologic setting, the plan for providing a digital geologic map, a prioritized list of geologic resource management issues, a description of significant geologic features and processes, lists of recommendations and action items, and a record of meeting participants.

## Park and Geologic Setting

Chiricahua National Monument was proclaimed a national monument April 18, 1924 and transferred from the U.S. Department of Agriculture, Forest Service to the National Park Service, August 10, 1933. It presently encompasses 11,984.73 acres in extreme southeastern Arizona. In 1976, Congress designated 10,290 acres as Wilderness (86 percent of the monument). Chiricahua NM was established to protect and preserve the exceptional geologic features in the monument including pinnacles, columns, spires and balanced rocks.

## Geologic Mapping for Chiricahua National Monument

During the scoping meeting Stephanie O'Meara showed some of the main features of the GRE Programs digital geologic maps, which reproduce all aspects of paper maps, including notes, legend, and cross sections, with the added benefit of GIS compatibility. The NPS GRE Geology-GIS Geodatabase Data Model incorporates the standards of digital map creation set for the GRE Program. Staff members digitize maps or convert digital data to the GRE digital geologic map model using ESRI ArcMap software. Final digital geologic map products include data in geodatabase, shapefile, and coverage format, layer files, FGDC-compliant metadata, and a Windows HelpFile that captures ancillary map data.

When possible, the GRE program provides large scale (1:24,000) digital geologic map coverage for each park's area of interest, which is often composed of the 7.5-minute quadrangles that contain park lands (figure 1). Maps of this scale (and larger) are useful to resource management because they capture most geologic features of interest and are positionally accurate within 40 feet. The process of selecting maps for management use begins with the identification of existing geologic maps and mapping needs in vicinity of the park. Scoping session participants then select appropriate source maps for the digital geologic data to be derived by GRE staff.

Map coverage for Chiricahua NM consists of 4 quadrangles of interest mapped at a 1:24,000 scale (figure 1): Cochise Head, Bowie Mountain South, Rustler Peak, and Fife Peak. These quadrangles are located on the Wilcox and Chiricahua Peak 30' x 60' sheets. Table 1 lists the source maps chosen for Chiricahua National Monument.

**Table 1. GRE Mapping Plan for Chiricahua National Monument**

Covered Quadrangles	GMAP <sup>1</sup>	Citation	Scale	Format	Assessment	GRE Action
Parts of Bowie Mountain South, Cochise Head, Rustler Park, Fife Peak	1120	Pallister, John S., DuBray, Edward A., 1997, Interpretive map and Guide to the Volcanic Geology of Chiricahua National Monument and Vicinity, Cochise County, Arizona, US Geological Survey, I-2541, 1:24000 scale.	1: 24,000	paper	GMAP 1120 covers the park boundary	Conversion of digital data to geodatabase data model/ will integrate into either FY06 or FY07 projects.
Rustler Park	8436	Pallister, John S., DuBray, Edward A., Latta, J.S., 1994, Geologic map of the Rustler Park quadrangle, Cochise County, Arizona, US Geological Survey, Geologic Quadrangle Map GQ-1696, 1:24000 scale.	1: 24,000	paper and digital	Maps Rustler Peak quadrangle and includes southern part of monument	Conversion of digital data to geodatabase data model/ will integrate into either FY06 or FY07 projects.
Fife Peak	8439	Pallister, John S., DuBray, Edward A., 1994, Geologic map of the Fife Peak quadrangle, Cochise County, Arizona, US Geological Survey, Geologic Quadrangle Map GQ-1708, 1:24000 scale.	1: 24,000	digital	Maps Fife Peak quadrangle, the quadrangle bordering the monument to the southwest	Conversion of digital data to geodatabase data model/ will integrate into either FY06 or FY07 projects.

<sup>1</sup>GMAP numbers are unique identification codes used in the GRE database.

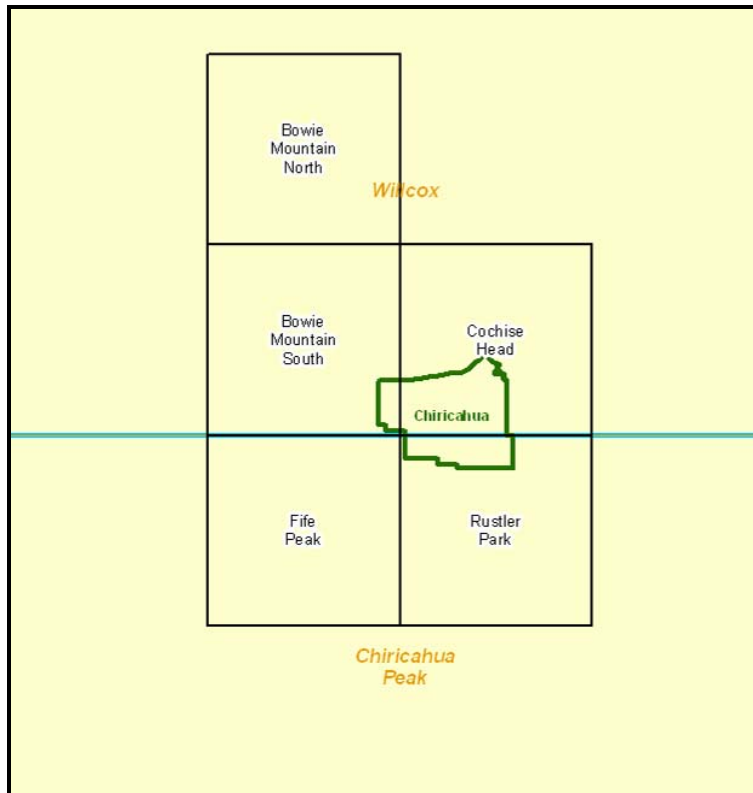


Figure 1. Quadrangles of Interest for Chiricahua National Monument, Arizona. The 7.5-minute quadrangles (scale 1:24,000) are labeled in black; names in yellow indicate 30-minute by 60-minute quadrangles (scale 1:100,000). Green outline indicates the boundary of the monument.

GRE staff have digitized the following GMAP:

- GMAP 1120: Pallister, John S., Du Bray, Edward A., 1997, Interpretive map and Guide to the Volcanic Geology of Chiricahua National Monument and Vicinity, Cochise County, Arizona, US Geological Survey, I-2541, 1:24000 scale.

GMAP 1120 covers to the park boundary. The four intersecting 7.5' quadrangles do have complete geologic map coverage, and if it is desired to have more of a buffer around the park, they could be digitized to enhance the existing digital geologic map.

GMAP 1120 is probably the best map available (Ed du Bray). The map focuses on the Turkey Creek volcano and surrounding area and contains a pamphlet suitable for the non-geologist. Ed du Bray considers GMAP 1120, however, to be a map that simply lays out the geologic framework of the park. More detailed mapping and subsequent research could be done, for example, on the world-class tuff deposits in Chiricahua. GMAP 1120 is sold at the Visitor Center.

Both the Paleozoic rocks in the northeastern part of Chiricahua NM and the Mesozoic rocks were difficult to map (Ed du Bray). Drewes mapped the Paleozoic rocks, but his mapping probably

needs to be revisited. Tim Lawton, head of the New Mexico State University Geology Department, helped John Pallister and Ed du Bray map the Mesozoic rocks on GMAP 1120.

Quaternary, surficial deposits at Chiricahua NM have not been mapped in detail although most every structure in the monument is built on Quaternary deposits (Todd Shipman, AZGS; Ed du Bray). The monument has a soils map, but the map has not been digitized (Carrie Dennett, NPS CHIR). Rhyolitic volcanic ash deposited in water alters to bentonite, a clay that has shrink and swell properties. Soils with shrink and swell characteristics and thin soils both could impact septic systems and the structural integrity of facilities so a soils map is important to the park. Pete Biggam (NPS GRD) should be consulted for questions regarding soils.

Because of the flooding potential at the Visitor Center expansion and campgrounds, a map of the Quaternary showing potential flood areas would be beneficial. Mike Martin (NPS WRD) visited Chiricahua NM and generated a 100-year flood map. Stephanie will contact Mike to see about digitizing his map for Chiricahua. Colleen Filippone (NPS Intermountain Region) also would like a copy of the map for the Chiricahua NM library.

Increased runoff and flooding associated with recent fires is an issue at the monument (Carrie Dennett). Fire increases the potential for slope erosion, and hazard maps showing areas prone to mass slippage would be useful for management. Hazard maps showing rock outcrops as natural fire barriers and areas of recent burns could also be helpful to park staff. Ed du Bray suggested that remote sensing could be used for this.

Colleen Filippone expressed an interest in more map coverage in Pine Canyon because of high visitation. Pine Canyon is located along the southern edge of GMAP 1120.

GRE mapping action planned for FY 2006 or FY 2007 includes:

- The GRE will convert existing digital data for GMAP 1120 from the GRE coverage and shapefile data model to the GRE geodatabase data model. This is required, as integration of newly acquired digital data will need to be in the same GIS format for edge-matching and compilation, and because the geodatabase format is now the standard GRE supported deliverable format.
- Ed du Bray of the USGS has recently supplied the GRE (acquisition date of April 17, 2006) with digital data in Shapefile (.shp) format, as well as digital text of ancillary text including map unit descriptions and references pertaining to GMAP 8436 (Rustler Park) and 8439 (Fife Peak quadrangle). The GRE will evaluate and convert the digital data to the GRE geodatabase data model format. The digital data will then be edge-matched and appended to existing GRE digital data GMAP 1120 to produce one compiled park map for Chiricahua NM. Ancillary text and figures associated with the two quadrangle maps will be formatted and incorporated with existing GRE CHIR project text and figures.
- The GRE will contact Mike Martin (NPS Water Resources Division) in Fort Collins concerning a floodplain map he recently produced for Chiricahua NM. The GRE will then determine if the map can be georeferenced for GIS digitization (this requires coordinate ties

and/or features present that can be used to assist georeferencing). If georeferencing is possible then the GRE will digitize the map to the GRE geodatabase data model format.

- The GRE will evaluate a scoping proposal to map Quaternary surficial deposits within the park, primarily deposited within drainages. This should prove helpful for debris flow and post-fire management.
- The GRE will evaluate a scoping proposal to re-map the area around the King of Lead Mine in and near the northeast area of the park. Ed du Bray stated that geology of the area was structurally complex and could be re-mapped by someone with more structural mapping experience.

## Geologic Resource Management Issues

The scoping session for Chiricahua National Monument provided the opportunity to develop a list of geologic issues, features and processes, which will be further explained in the final GRE report. Table 2 presents a summary of potential hazards or features discussed during the scoping meeting and the issues these hazards may present to management.

**Table 2: Hazards associated with issues, features, and processes at Chiricahua National Monument.**

Hazard	Issues, Feature and Processes
Flooding	Large watershed catchment area; affects Visitor Center & campgrounds
Septic	Thin soils; bentonite; flooding
Shrink and swell soils	Collapseable clays; shrink and swell properties
Interpretive needs	Displays are not geologically correct
Landslides	Potential for large landslides in southeast Chiricahua NM & along Sugarloaf trail
Old mines	Safety issues; acid mine drainage?
Mineral and/or rock collecting	Spherulites – collected by visitors; mineral (Pb/Zn) specimens
Post-fire erosion	Steep slopes denuded by fire tend to erode
Rock climbing	Not allowed in park
Seismicity	Not a significant issue for the pinnacle features and columns
Caves/karst	Not an issue
Geothermal	Not an issue
Active faults	Not an issue

During the meeting, Alan Whalon (NPS CHIR-FOBO) prioritized the most significant issues as follows:

- (1) Flooding
- (2) Sewer and septic problems, and
- (3) Information for interpretation

Other geologic resource management issues discussed included: mining issues, landslides, mineral specimen collecting, subsurface contamination from a leaking underground storage tank, and rock stability associated with fractures and faults in the rocks.

## **Flooding**

Mike Martin advised the park that slopes were so steep, flooding would occur too quickly for evacuation (Carrie Dennett). Todd Shipman (AZGS) suggested that rather than developing a warning system, which would not be adequate, the monument could identify areas prone to flooding and avoid locating facilities in those areas. Carrie Dennett pointed out that, unfortunately, the Visitor Center and campgrounds are located in the floodplain, and the monument has no plans to relocate those facilities. Campgrounds have been closed in the past due to 100-year floods. Park management is concerned that visitors new to the area won't recognize the potential for flooding in the campgrounds because they see the area as a "desert" (Alan Whalon).

## **Sewer and Septic Problems**

Issues associated with the sewer and septic system at Chiricahua National Monument may be more related to money than to geology (Alan Whalon). The septic system is old and deteriorating. A good location for a septic system is difficult to find.

## **Information for Interpretation**

The interpretive displays at Sugarloaf Mountain need to be redone (Ed du Bray). These displays show a stratovolcano with steep slopes, but this area had gentle slopes that erupted through ring fractures, not a central vent. Alan Whalon commented that the monument focused on the pinnacle features, but the whole geologic story is much more interesting. However, a geologist has not been employed by CHIR for some time. Suzanne Moody (NPS CHIR) suggested a need to emphasize the caldera study in their interpretive material. The geology of Chiricahua NM might be used to tie in other themes such as natural history, culture, vegetation, and biology.

## **Other Issues**

The King of Lead mine, adjacent to the northeast boundary of Chiricahua NM, consists of four patented mining claims. The mine was active up to about 1984 when access to the mine through the monument became an issue. The lead-zinc deposits of the mine formed as a result of magma interacting with Paleozoic rocks and may be related to an unknown caldera around Cochise Head. A few other small, lead-zinc deposits are related to Turkey Creek. These mines, including the King of Lead mine, are presently not economic.

Acid mine drainage from mines adjacent to CHIR may be an issue. King of Lead mine drains to Bonita Creek. There is no surface flow for most of the year, however. Mike Martin performed some water quality tests and was skeptical of the results, which showed no impacts (Colleen Filippone). If funds for sampling could be found, groundwater sampling might prove beneficial. The mine owner would sell the mine to the monument for several million dollars. Alan Whalon explained that old mines were an issue about ten years ago, but today there are no safety or bat habitat issues.

Vast landslide deposits of an unknown age are located in the southeastern area of Chiricahua NM (Ed du Bray), creating the potential for large landslides. A slump recently occurred along the Sugarloaf trail closing it for 1.5 years. The slump is associated with a distinctive white volcanic ash zone that is easily eroded, undercuts the overlying cliff, and results in collapse. Washouts along a Civilian Conservation Corps (CCC) trail during trail rehabilitation closed the trail for six months.

Collecting mineral specimens probably is more of a park management issue than is hardrock mining for economic mineral deposits. In addition to lead-zinc mineral specimens (galena, sphalerite), spherulite collecting is an issue for park management. The marble-like spherulites (nicknamed “hailstones”) weather out of volcanic tuff along the Hailstone trail.

Regarding subsurface contamination (soil and groundwater), an underground storage tank was pulled out about twelve years ago and found to be leaking. Decontamination continues because the geometry of the contaminant plume is difficult to define and mitigate (Alan Whalon).

Although horizontal and vertical fractures cut the rocks, a study of some of these structures showed that they are stable (Ed du Bray). In 1887, a 7.2 M earthquake (the Pitaicachi earthquake) did not destabilize the columns. During a road project, a large rock fell on the road following a rainfall (Alan Whalon). Seismometers were placed in the area to detect vibrations from heavy equipment and from small dynamite charges. This small but “interesting” study suggested that one of the biggest issues regarding rockfall was climbing on the rocks (Alan Whalon). Chiricahua NM does not allow climbing and the study is additional evidence for not allowing this recreational activity in the monument.

## **Features and Processes**

Ed du Bray led a field trip to the top of Sugarloaf Mountain to observe features related to the Turkey Creek caldera. Features observed along the Sugarloaf trail included:

- Pinnacles, columns, spires, and balanced rocks
- Erosional remnants of igneous dikes exposed near the King of Lead mine
- Middle and Upper units of the Rhyolite Canyon Tuff and associated features
- Remnants of the slump resulting from erosion of the conspicuous white ash unit and undercutting of Unit 3
- Structures that suggest the white ash unit is a surge deposit at the base of Unit 3 rather than an ash cloud deposit at the top of Unit 2
- Fumerole pipes
- The “boiling pot” of a fumerole
- Liesegang bands where small amounts of chemical impurities from hot water were precipitated
- The only place in the Chiricahua Mountains where the dynamic contact between Unit 2 and Unit 3 is exposed
- An overall panoramic display of the caldera remnants from the top of the mountain

Other features in Chiricahua National Monument include:

- Columnar joints in the rhyolite
- Spherulites (marble-like rocks found along Hailstone Trail)
- Vertical volcanic flow structures
- Landslides and mass wasting features (erosional processes)
- Vertical and horizontal fractures (tectonic and cooling processes)
- Inverted topography caused when the volcanic eruption initially exploded and redeposited strata closest to the earth’s surface and then ejected and deposited more deeply buried, older

strata on top of the originally younger rocks. The stratigraphy, thus, is now “inverted” from its original sequence.

## Recommendations

Recommendations from the scoping meeting include:

- More detailed mapping and research on the tuff deposits,
- Maps showing the relationship between geology and vegetation,
- A map identifying flood prone areas
- A hazard map showing rock outcrops and potential post-fire slope failure,

## Action Items

No action items were discussed at the meeting.

**Table 3. Scoping Meeting Participants**

Name	Affiliation	Position	Phone	E-Mail
Covington, Sid	Geologist	NPS GRD	303-969-2154	sid_covington@nps.gov
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du Bray, Ed	Geologist	USGS	303-236-5591	edubray@usgs.gov
Filippone, Colleen	Hydrologist	NPS, Intermountain Region	520-546-1607	colleen_filippone@nps.gov
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